5.0 Ongoing Environmental Monitoring Programs and O&M Requirements

To evaluate the effectiveness of the remediation measures described above, the City has conducted performance and compliance monitoring programs at the Midway Landfill since 1989. These include fluid level monitoring, groundwater chemistry monitoring, and landfill gas monitoring that are performed on an ongoing basis. The current monitoring program is described in the Midway Landfill Monitoring Plan (Parametrix 2000a).

The O&M requirements for Midway Landfill are described in Midway Landfill Operation and Maintenance Manual completed in 1992, (Parametrix). This document is a comprehensive operation and maintenance manual for both short-term and long-term operation and maintenance for the systems constructed under the consent decree was prepared by the City of Seattle, and was approved by Ecology in April 1992. The manual addresses operation and maintenance of all components of the remedy including; gas system, surface water systems, pump stations, landfill cover system, roadway and site control.

5.1 Fluid Level Monitoring

An extensive formal fluid level monitoring program began in October 1989 and has been conducted monthly, quarterly, or semi-annually through sampling Round 47, March 2005. In 1993 the monitoring frequency was reduced to a semi-annual schedule. Fluid level monitoring was previously referred to as "Performance Monitoring" and is intended to track response of landfill leachate levels and shallow groundwater levels to remedial actions required by the consent decree. It includes collection of groundwater level and oil thickness measurements within the saturated portion of Midway Landfill (termed Saturated Refuse) and groundwater levels in the shallow groundwater surrounding the landfill (Shallow Groundwater). The fluid level monitoring network for the Shallow Groundwater and Saturated Refuse is shown in Figure 7. Fluid level monitoring is currently being conducted on a biannual basis and the current program (Parametrix 2002) consists of:

- Monitoring seven wells from the key hydraulic areas (south end, hydraulic sink, west side, central mound, Linda Heights, north end, north end shallow) of the landfill twice a year beginning in 2002 during Round 41. These wells monitor the Shallow Groundwater/Saturated Refuse (SG/SR). The measurements from these wells are being compared to historical data to evaluate continued effectiveness of the closure measures.
- Monitoring 61 additional wells from the SG/SR once every other year beginning in 2003 (Round 43). Measurements from these wells are being compared to historical data as described above, and used to evaluate groundwater flow within the SG/SR and oil thickness trends.

5.2 Groundwater Chemistry Monitoring

Groundwater chemistry monitoring was initiated in February 1990 with Round 1 (QM-1) and has been conducted on a quarterly or semi-annual basis through sampling Round 46 in 2004. Groundwater chemistry monitoring has also been referred to as "Compliance Monitoring" in previous documents and is intended to track the presence, concentrations, and migration of groundwater contaminants, both upgradient and downgradient of the landfill, to assess the effectiveness of the remedial actions.

The first semi-annual groundwater chemistry event was Round 34 (QM-34). The current groundwater chemistry monitoring program includes collection and qualitative analysis of groundwater samples collected from monitoring wells located upgradient and downgradient of the landfill and groundwater flow determination. The well locations currently used for groundwater level measurements are shown in Figure 8. The well locations currently used for groundwater chemistry monitoring are shown in Figure 9.

5.3 Landfill Gas Monitoring

Gas monitoring is conducted on a biweekly, weekly, monthly, or quarterly basis; it consists of checks for concentration, composition, temperature, flow, and velocity of gases.

Monitoring and a monitoring plan are not specifically identified as required activities in the 1990 consent decree. An amendment to the consent decree will specify a requirement to implement a compliance monitoring plan approved by Ecology, as well as to implement an operations and maintenance plan. The City of Seattle and Ecology agreed upon a long-term monitoring plan in April 2005 and amended the consent decree to include the monitoring plan.

6.0 Monitoring Results

6.1 Groundwater Flow Determination

Potentiometric contour maps have been generated regularly with each monitoring round for the Upper Gravel Aquifer, the Sand Aquifer, and the Southern Gravel Aquifer. The monitoring well locations are shown in Figure 8. The most current results are shown in the 2004 Annual Groundwater Monitoring Report and the 2005 Groundwater Remediation Status Report 5-Year Review. (Parametrix 2005a, 2005b).

Flow patterns in the Upper Gravel Aquifer and Sand Aquifer have remained relatively stable during the period of record. Flow patterns in the Southern Gravel Aquifer have also remained relatively stable, although recent data in the vicinity of well MW-30C indicate that the flow direction in that area is more northeast/northwest instead of east/west as measured during the remedial investigation. This change has not affected the upgradient and downgradient relationships within the SGA, except that well MW-30C appears to be in a cross-gradient direction relative to the influence of the landfill.

In general, the fluid levels in the shallow groundwater and saturated refuse have declined over time and the overall shape of the potentiometric surface has undergone little change over the last 15 years. The overall flow patterns within and directly under the landfill have generally remained constant over time.

6.2 Water Quality Monitoring

The most recent groundwater quality results are published in the 2004 Annual Groundwater Monitoring Report (Parametrix, 2005a). Summary tables of

groundwater quality data and trend plots of key downgradient and upgradient wells are attached in Appendix C.

The cleanup levels were exceeded for 1,2-dichloroethane and vinyl chloride in samples collected from one upgradient well in the Sand Aquifer (MW-17B) and in samples collected from all five downgradient wells in the Southern Gravel Aquifer (MW-14B, MW-20B, MW-23B, MW-29B, and MW-30C) during the 2004 sampling rounds.

Three additional volatile organic compounds (1,1-DCE; tetrachloroethene [PCE]; and Trichloroethene [TCE]) have shown steadily increasing trends in well MW-21B. Concentrations of these VOCs are above applicable standards (federal Maximum Contaminant Levels (MCLs) for drinking water, and Model Toxics Control Act (MTCA) Method B groundwater cleanup levels), and have shown increases over time.

Manganese has exceeded the cleanup level in one downgradient well (MW-20B) during the 2004 sampling rounds.

Examples of time-series plots illustrating the levels of volatile organic compounds and trends over time in monitoring wells are attached in Appendix C.

The source(s) of upgradient contamination of the Midway Landfill in the Sand Aquifer is still present as indicated by data from upgradient monitoring well MW-21B. The results from these two wells show two different time-concentration trends. The concentrations of several volatile organic compounds detected in MW-17B are decreasing while the concentrations of several volatile organic compounds in MW-21B are increasing. Downgradient groundwater concentrations of volatile organic compounds in the Sand Aquifer and the Southern Gravel Aquifer continue to be affected by this undetermined contamination source.

Upgradient sources of VOCs in groundwater will continue to limit the potential for the chemicals of concern in the Southern Gravel Aquifer to decrease below the ROD cleanup levels, especially because the concentrations of volatile organic compounds in upgradient Sand Aquifer well MW-21B are

increasing over time. Vinyl chloride is a daughter product of the ethenes and ethanes detected in upgradient wells, and both vinyl chloride and 1,2-DCA are also present upgradient of the landfill.

The chemical 1,4-dioxane will be added to the next sampling round at monitoring wells 14B, 17B, and 21B; both wells are upgradient wells with concentrations of volatile organic compounds in the Sand Aquifer at those locations.

6.3 Nature and Extent of Gas Migration

The Upper Gravel Aquifer beneath the landfill is under vacuum from the landfill gas collection system. In 1984, following the initial detection of widespread gas migration outside of the landfill boundary, numerous actions were initiated to extract and control gas migration. Currently 136 offsite gas probes and 139 on-site gas extraction wells are monitored regularly for landfill gas. In the past 6 years (1999-2004), there have been no exceedances of the regulatory value for methane concentrations outside of the landfill.

As of 1997, none of the off-landfill property gas extraction wells were still in use because of the significant decreases in off-property methane gas concentrations. All gas probes and gas monitoring locations surrounding the landfill are under the state's landfill gas regulatory limits and all such monitoring locations where the limit may be approached are under the influence of the gas collection system. During the remedial investigation, numerous hazardous substances were found in the extracted landfill gas including vinyl chloride, xylenes, toluene, benzene and other solvents.

6.4 Surface Water, Seeps, and Soil Contamination

Surface water, seeps and soils in areas around the landfill were sampled in the late 1980's as part of the RI and no contamination from the Midway Landfill was found. Sampling was discontinued for the lack of detection of contaminants.

Whenever there is sufficient flow, the storm water discharged from the stormwater detention pond is monitored for turbidity, dissolved oxygen, PH, temperature and conductivity five day a week during conditions of flow.

6.5 Non-Aqueous Phase Fluid Monitoring

Oil thicknesses in the Shallow Groundwater and Saturated Refuse have generally decreased over the history of monitoring. Only three wells (31, 39D, and 43D) continue to show oil thicknesses of approximately one foot or more. Rapid declines in the measured oil thickness in these wells were observed during the RI period in 1988 and 1989, followed by slight increases through the early 1990s. Since that time, oil thicknesses at 31 and 39D have declined from highs of approximately 8 feet, to approximately 3 feet, and 1 foot, respectively. The oil thickness is regularly measured.

7.0 Measured Effectiveness of Remediation on Fluid Levels

The remediation measures at the Midway Landfill have had a substantial measured effect on fluid elevations, as represented in the potentiometric surface maps, fluid level change maps, and hydrographs in the periodic monitoring reports. The landfill fluid levels have substantially declined from 1989 to 2005 due to the remedial actions. The effectiveness of the remedial actions on fluid levels in the landfill is summarized below.

7.1 Landfill Surface Filling and Detention Pond Construction

Infiltration to the Saturated Refuse from the former surface ponds is estimated to have been 30 to 45 million gallons per year (AGI 1988). Filling of the ponds and complete construction of the lined detention pond in June 1989 has reduced recharge from the surface in the northern and western areas of the landfill. Hydrographs for the west side wells and the fluid elevation change maps show a steady reduction in fluid levels since this time and are evidence of this reduced recharge. Hydrographs for the northern area reflect stable conditions.

7.2 Landfill Cap Installation

Pre-remediation recharge to the Saturated Refuse due to precipitation has been estimated to be approximately 50 to 70 million gallons per year (AGI, 1988). Completion of the cap has reduced recharge significantly. The downward trends seen in the hydrographs and the declines in fluid levels in the west side, south side, and central mound areas demonstrate cover effectiveness.

7.3 Linda Heights Park Storm Water Diversion

The estimated discharge from the Linda Heights Park drain to the landfill ranged from 14 to 55 million gallons per year (AGI, 1990). Analysis of the hydrographs for the Linda Heights Park and central mound areas and the fluid level change maps are evidence that the cut-off of this source of recharge has been very successful in reducing fluid levels in the landfill. Specifically, the hydrographs in the Linda Heights Park area no longer show large peaks during the rainy season, and hydrographs from the central mound area show a continued decrease in fluid levels.

8.0 Updated Review of Upgradient Sources

The ROD acknowledged that contaminated groundwater is flowing toward and under the landfill from upgradient sources, and that some contaminant levels exceed federal and state drinking water standards and MTCA cleanup levels. The upgradient contamination may impact the ability of current and future groundwater leaving the landfill to meet groundwater cleanup standards.

8.1 Background and Summary of Previous Investigations

A hazard assessment was conducted by Ecology in 1990 (SAIC 1991) to identify potential sources of groundwater contamination detected upgradient of the Midway Landfill during the RI. This study identified several potential sources for the chlorinated ethenes and ethanes northwest and upgradient of the landfill, in the vicinity of Pacific Highway South and South 248th Street.

In October 1998, Parametrix conducted a database search to identify sites upgradient of the landfill where historical contaminant releases have occurred (Parametrix 1998). In March 2000, Ecology files were reviewed for 16 of these sites that had confirmed releases to the environment or were properties of potential environmental concern (Parametrix 2000b). The results of the report confirmed the potential for area groundwater contamination from numerous sources upgradient of the Midway Landfill.

8.2 Findings of Updated Study

As part of this five-year review, a database search by EDR Environmental was conducted to assess the status of the properties previously identified, and to determine whether additional contaminated sites have been identified during the past five years (Parametrix, 2005b).

The 2005 EDR report continues to document the presence of many sites upgradient from the Midway Landfill where hazardous substances are present. These include sites without known releases such as RCRA small quantity generators and underground storage tanks sites with existing or former underground storage tanks, as well as sites where documented chemical releases have occurred.

In 2000, the 16 sites that were researched continued to be cited in the databases, and no change in status for any of these sites could be discerned from the available information.

In the 2005, the EDR report identified three additional sites with suspected or documented releases of organic solvents. Three sites (two of the additional sites and one of the previous 16 sites) with solvent releases are in the general vicinity of upgradient well MW-21B. This well has shown increasing concentrations of volatile organic compounds.

The Washington Department of Ecology will contact the owners of the sites identified as possible contaminant sources. The owners will be encouraged to work cooperatively with the Department of Ecology to voluntarily investigate and remediate contamination.